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Newsletter

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Spruce Budworms
Program

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Use of Chemical Insecticides against the Spruce Budworm in Eastern Canada

The spruce budworm (*Choristoneura fumiferana* Clem.) is currently infesting more than 60 million hectares (148.3 million acres) of forest in North America. It is threatening the wood supply of industry, employment, the aesthetic value of the forest, habitat of wildlife, fish-bearing streams, human recreation activities, and is also increasing fire hazard to the forest. The Cape Breton Highlands is an example of what can result from a decade of devastation if no forest protection operations are instituted.

"It's that time of year again . . . . . .".

Chemical control operations with insecticides against the spruce budworm have traditionally been carried out when natural control agents (parasites, predators, and pathogens) or cultural practices have failed to protect the forests from widespread damage, and when economic or aesthetic losses have been judged to exceed the cost of control operations. In large scale infestations covering millions of hectares, the only practical tactic at the present time for combating this pest is the aerial application of chemical insecticides. Research on alternate insecticides and methods i.e., microbial insecticides (*Bacillus thuringiensis* (B.t.), viruses and protozoans, etc.), insect growth regulators, sex pheromones, genetic manipulation, and various silvicultural practices are in progress. B.t. can be used effectively in certain situations and other materials are showing considerable promise. New formulations of B.t. may prove effective for operational control in the near future.

The technique of aerial application of chemical insecticides against the spruce budworm was developed in the mid-1940's. The philosophy and science of application of insecticides are constantly changing to accommodate environmental, political, and economic factors that affect the forest industry.

During the mid-1940's, with the advent of DDT and availability of surplus military aircraft, an ambitious philosophy of "extermination" of budworm from the forest was practiced by spraying DDT at the rate of 1.121 kg/ha (1 lb/acre) or more in order to achieve a control of 95 percent or better over budworm populations. However, by the mid-1950's, with the awareness of off-target side effects on salmon fry in the Miramichi River, and due to the economics of application, the philosophy of "extermination" was changed to a strategy of "population reduction" and "foliage protection." Application rates of DDT were reduced to 0.560 kg/ha (0.5 lb/acre) or less and a lower percentage of control was accepted.

During the mid-1960's, significant advances were made in spray emission equipment and spray aircraft, which resulted in the development of low volume application technology. At the same time more effective organophosphates, phosphamidon and fenitrothion, were developed for forestry use in Canada. These advances, coupled with the increasing concern for the impact of pesticides on nontarget organisms and continuing adherence to a foliage protection philosophy, resulted in further reduction in the amount of active ingredient to a range 0.14-0.28/kg/ha (0.125-0.25 lb/acre).

Advances in forest spray technology during the 1970's included adoption of multi-engined aircraft equipped with sophisticated inertial guidance systems and further development of ultra low volume techniques for the aerial application of pesticides. Development of the more

Table 1. Use of Chemical Insecticides for Control of Spruce Budworm in Eastern Canada, 1965-1980.

Year	Provinces	Thousands of Kilograms of Active Ingredients Used Annually							Totals (1,000's)				Infestation in Thousands of Hectares		
		DDT	Phosphamidon	Fenitrothion	Aminocarb	Mexacarbate	Trichlorfon	Acephate	Kilograms	Hectares Treated	% Corr Larval Mort.	% Foliage Saved	Area Infested*	Tree Mortality	% of Area Treated
1965	N B	297 8	37 8	—	—	—	—	—	335 6	844 1	(73)	—	1,602 6	—	52 7
1966	N B	448 2	47 4	—	—	—	—	—	495 6	799 0	(81)	—	728 5	—	109 7†
1967	N 8	160.1	20 6	35 7	—	—	—	—	216 4	420 4	(74)	—	631 3	—	66 6
1968	N 8 Ont	8 5	33 B	72 6	—	—	—	—	114 9	323 7	(75)	—	1,954 6	3 2	16 6
1969	N B , Ont	0.7	—	325 0	—	0 7	—	—	326 4	1,257.7	(85)	35	4,111 7	—	30 6
1970	N B Ont	—	26 1	391 8	0 8	—	1 1	—	419 B	1,718 9	(74)	65	7,669 0	149 7	22 4
1971	N B Ont P O	—	—	741 4	1 7	0 3	—	—	743 4	3,299 7	(80)	40	12,788 4	—	25 8
1972	N B Ont P O	—	—	656 0	1 6	1 6	—	—	659 2	2,566 7	(62)	35	21,691 6	—	11 8
1973	N B Ont , P O	—	242 1	1,356 7	6 4	3.0	0.3	—	1,608.5	5,729 4	(64)	45	24 274 7	1,007 7	23 6
1974	N B Ont P O	—	197 0	656 4	51 0	44.2	6 0	0 01	954 6	4,559 1	25	25	41,040 1	1,983 0	11 1
1975	N B Ont P O	—	568 4	946 7	52 3	—	64 2	0 7	1,632 3	9,090 0	40	40	49,939 3	5 180 1	1B 2
1976	N B Ont , P O	—	13 4	2,052.3	174 2	—	119 7	0 4	2,360 0	6,701 5	60	50	46,382 1	7,405 9	14 4
1977	N 8 Ont P O NFLD	—	133 8	650 7	148 8	—	127.0	0.2	1,060.5	4,720.2	63	30	46 127 0	11 210 0	10 2
1978	N B Ont P O NFLD	—	—	430 1	240 4	—	—	0 1	670 6	3,546 5	60	—	40,012 2	12 950 2	8 9
1979	N B Ont., P Q	—	—	38.3	206 1	—	—	0 9	245 3	2,318.5	—	—	29 259 4	18,029 4	7 9
1980	N B Ont , P O (Proposed)	—	—	660 B	32.2	—	—	0.5	693.5	1,808 2	—	—	—	—	—
	Total kilograms (1,000's)	915 3	1,320 4	9,014 5	915.5	49 8	318 3	2 8	12,536 6						
	Total pounds (1,000 s)	2,017 9	2,911 0	19,873 5	2,018 3	109 8	701.7	6 2	27,638 4						
	Total hectares treated (1 000 s)	1,789 0	7,286.5	30,661 5	9,472 0	98 3	387 4	8 9		49,703 6					
	Total acres treated (1 000's)	4 420 6	18,004 9	75,764 6	23,405.3	242.9	957 3	22.0		122,817.6					

N B — New Brunswick, Ont — Ontario; P O — Province of Quebec, Nfld — Newfoundland % Correct Mort — percent corrected larval mortality by Abbott's formula

These figures are approximate (compiled from Forest Pest Control Forum and Annual Forest Insect and Disease Survey Reports)

Corrected Mortality shown in parenthesis is for New 8runswick only

* — Moderate to heavy infestation

† — In 1966 area with light infestation was also treated

effective and relatively safer carbamates, aminocarb and mexacarbate, during this period, further reduced the dosage of active ingredients to 0.052 kg/ha (0.046 lb/acre) applied twice or 0.105 kg/ha (0.094 lb/acre) applied once. These advances allowed for the treatment of vast areas in a very short time and a further reduction in the amount of pesticides used per unit area on the treated forest. For example, some 15.8 million hectares (39 million acres) of budworm-infested forest were treated during 1975 and 1976, mostly in Quebec and New Brunswick, with an average insecticide application of approximately 0.25 kg/ha (0.22 lb/acre) as compared to a total of some 1.6 million hectares (3.95 million acres) in 1965 and 1966, all of which was in New Brunswick, with an average of about 0.50 kg/ha (0.44 lb/acre) (Table 1). During the mid-1970's, the spruce budworm outbreak in eastern Canada spread to a total of approximately 49.9 million hectares (123 million acres). The treated area increased dramatically in response to the infestation, but the proportion of the treated forest to that needing treatment declined during this period due to a shortage of chemicals, economic constraints, and mounting public sentiment against the wide scale use of chemical insecticides in the forestry context.

During the latter part of the 1970's, there was a gradual decline in the treatment of infested forests in eastern Canada and an increase in dead or dying forests (Table 1) as a result of political reaction to public pressure over the Reye's Syndrome controversy, suspected carcinogenicity of fuel oil and the toxicity of nonylphenol, cosolvent of aminocarb formulation, to aquatic organisms. Unless the situation is reversed, although most of these concerns were based on inconclusive data, it is highly likely that this trend will persist into the 1980's with more and more forest being sacrificed to the budworm.

The experience of approximately four decades of chemical control of forest pests in Canada has demonstrated conclusively that forests can be protected economically from unacceptable damage caused by the spruce budworm, and be kept alive until they can be harvested or until more acceptable pest control products and strategies for spruce budworm management can be developed. With current thrusts in Canada directed at more intensive forest management that will increase the forest harvest by 50 percent by the year 2000 and double the real benefit flow from the forestry sector, it is obvious that the present forest must be protected if these forestry goals are to be achieved. In addition, the new forests developed as a result of sound planning and extensive investment in more intensive forest management will likewise have to be protected. Furthermore, new and improved approaches to pest management are needed to complement this trend to intensive forest management which will allow forest managers either to prevent massive outbreaks of the spruce budworm from developing in the first place, or if they do, to apply integrated systems of pest management which will regulate pest populations at acceptable levels, reduce damage, and maintain the integrity of the forest environment. This is the challenge of the 1980's.

The use of chemical insecticides will be integrated with other new techniques during the 1980's as soon as these techniques are available for operational use. A more restrictive and judicious use of chemical pesticides may evolve during the 1990's by the availability of new approaches and in response to political pressures from public criticism on the widespread use of chemical pesticides in the forest environment.

P.C. Nigam — Forest Pest Management Institute
Sault Ste. Marie, Ont.

Fire Behavior Seminar Looks at Threat of Budworm Damaged Trees

Sixty representatives of Forest Protection agencies gathered in Gander, Newfoundland, April 1, 1980, to take part in a seminar entitled "Fire Behavior in Budworm-Damaged Forests." The day-long seminar, sponsored by the Newfoundland Forest Research Centre, featured a slide-illustrated presentation by Brian Stocks, Fire Research Officer with the Canadian Forestry Service at Sault Ste. Marie, Ontario.

In an introductory paper titled "Fire Research in the Spruce Budworm Program," Dr. John Hudak of the Newfoundland Forest Research Centre, outlined the present organization of spruce budworm research in eastern Canada, making specific reference to the role of fire research in the overall program. He noted that the fire research group had been assigned the task of "defining fire behavior in budworm-damaged stands, such that forest fire managers can allocate resources accordingly."

In a paper titled "Forest Fire Behavior in Spruce Budworm-killed Balsam Fir," Brian Stocks outlined the fire problem resulting from spruce budworm infestation and the approach that was being taken at the Great Lakes Forest Research Centre by developing fire behavior indices through both wildfire monitoring and the use of experimental fires. Through the use of an excellent set of color slides, he showed the range of forest fuels, the establishment of experimental burning sites, and the actual burning of test plots in both spring and summer. He indicated that while both forest fuel and weather conditions in Ontario differed from those in Atlantic Canada, it was hoped that some findings from test fires in Ontario might apply to budworm-killed forests in Newfoundland. Great emphasis is being given to test fires in Ontario, and studies involving fire history, fuel accumulation, and fire weather index might be appropriate for implementation in Atlantic Canada.

Three spokesmen offered comments on behalf of their respective forest protection agencies: Joe Doyle, Director of Forest Protection with the Dept. of Forest Resources and Lands; Wilfred Dickson, Chief Forester with Bowater Newfoundland Limited; and Eric Burton, Chief Forester with Price (Nfld.) Pulp and Paper Limited. A general discussion on both the Ontario test fire program

and prescribed burning followed. The general consensus appeared to be that while fuel conditions in budworm-killed forests in Newfoundland might not be as hazardous as those found in Ontario, much valuable information could result from a study implemented locally to determine the effect that these forest fuels would have on fire behavior.

The following agencies had representatives at the seminar: Dept. of Forest Resources and Lands, Price (Nfld.) Pulp and Paper Limited, Bowater Newfoundland Limited, Parks Canada, Bay St. George Community College, United Brotherhood of Carpenters & Joiners of America, and the Canadian Forestry Service.

Activity A and D Meetings

The scientists responsible for the impact components of Activity A and for the budworm dynamic components of Activity D met in Fredericton on April 13, 1980. The chairman, Charlie Miller, started the meeting with a talk on the information needs of the forest managers at an operational, management, and provincial level.

Gordon Baskerville, newly appointed Assistant Deputy Minister of forest resources in the New Brunswick, Department of Natural Resources, also spoke to the group. He discussed the gap between "good research" and the "quick and dirty" methods available for the forest managers, and showed concern that research scientists are often so exact they are afraid to express ideas that might be valuable. According to Gordie, there is a need for a growth loss model which current projections do not have. The model must be state dependent; i.e., it must be able to answer "what if" questions.

During most of the 3-day meetings the two activity groups worked separately. Activity A — Forest Response (Impact) Group devoted most of its time to discussing aspects of the 0-5 year time frame. It was generally agreed that the major need here was annual 2-5 year forecasts (best guesses based on current knowledge) of risk — what kind of forests are most vulnerable and what is the budworm likely to do to them in terms of tree condition (primarily tree mortality). Also stressed was the necessity of understanding how this risk forecast can be plugged into the provincial wood allocation and management planning process. It was felt that a concerted effort should be made to develop 2-5 year projections on tree decline, mortality, and deterioration.

Activity D — Budworm Dynamics (Management Strategy) led by Jacques Regnière (GLFRC) performed a detailed review of Holling's model of budworm dynamics. There are a number of assumptions in the model that were "flagged", that is, identified as problem areas. It was decided that future meetings would be held to develop an alternative model.

CFS Impact Studies Reorganization

Don Ostaff (MFRC), leader of the new Impact Studies grouping, reports promising advances in organizing a revitalized approach to CFS research on the short and medium-term impacts of budworm on the forest. The objective of this activity grouping is a detection — appraisal — prediction system that will permit more enlightened resource management decisions. Research will permit us to devise rules combining budworm abundance and its impact on host trees, compatible with provincial inventory and management systems, which will allow the forest manager to predict annually within his operational unit the amount and location of tree mortality up to 5 years ahead. The whole activity area is divided into two major components, one synthesizing existing information and the other advancing research. In the first group, Paul Benoit (LFRC), Les Magasi (MFRC), Lloyd Sippell (GLFRC), Bob Blais (LFRC), and Art Raske (Newfoundland FRC) are taking leadership roles; in the other group, Les Magasi, Lloyd Sippell, Don Ostaff, Don MacLean (MFRC), and Chris Sanders (GLFRC) are heavily involved.

Much of the information required to devise predictive rules, we suspect, is in the reports and files of the various research centres. Paul Benoit is currently in process of leading the team that is extracting this information, and we expect that by the end of the year we will have our first output of the program. Meanwhile Don Ostaff is busy regrouping impact research so as to obtain the best possible information for the task ahead. Progress, of course, will be slower in this venture.

Don has been coordinating the activities of the whole group, which has met twice since the Working Group meetings in Toronto last fall. Don has a big job ahead of him in leading this program, which is probably the most diverse in the new CFS action plan for budworm research.

The Petawawa National Forestry Institute is investigating the improvement of remote sensing for detection and appraisal. Remote sensing experts, Peter Kourtz and Phil Gimbarzevsky, are cooperating with entomologists to incorporate aerial photography and satellite imagery into the system.

B.t. Research

The evaluation of microbial agents for control of spruce budworm and their development is a major objective of the CANUSA program. *Bacillus thuringiensis* (B.t.) is the leading microbial insecticide candidate for truly operational use during the short life of the Program; in fact, some formulations of B.t. have been registered for some time and used on fairly large spray blocks. Abbott Laboratories have recently introduced, and registered with EPA, an oil emulsion formulation of B.t. called DIPEL 4L (DIPEL 88 in Canada). Reports from preliminary field evaluations in Maine, New Brunswick, and Nova Scotia last year indicate that DIPEL 4L may offer better efficacy than previous B.t. formulations. One of the major reasons given for the limited use of B.t. in budworm control has been variable results; sometimes good population reduction has been achieved, but at other times neither larval mortality nor defoliation reduction has been satisfactory.

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The CANUSA Program intends to thoroughly evaluate the efficacy of two major B.t. formulations in 1980; DIPEL 4L and Thuricide 16B (Sandoz, Inc.). After consultation with interested and knowledgeable scientists, we have designed a "core" test work plan and intend to implement this same test in several geographical areas. The core work plan involves plots of DIPEL 4L, Thuricide 16B, and control (no spray). We refer to it as a "core" test because some cooperators will be adding additional treatments or will gather additional data from their plots, beyond what is required by the core work plan. All core plan B.t. treatments will be single applications, using small fixed-wing aircraft, at a dosage of 8 BIU in 1 gal/acre (11.2 L/ha). Data collection will be identical on all treatment plots and recorded on uniform data sheets. A composite report on the results of all core test treatments will be prepared and published next fall.

Arrangements with cooperators in the various geographical areas have not been completed at the time this article was written, but we expect to have participation in Arizona, Ontario, Quebec, New Brunswick, Maine, New Hampshire, and Minnesota or Wisconsin. Funding for the core test locations will be shared by CANUSA (United States and Canada), Abbott Laboratories, and Sandoz, Inc.

Spruce Budworm Pheromone

The pheromone for the spruce budworm has been identified and seems to offer potential as a useful survey/evaluation tool for forecasting population trends in low to medium (non-outbreak) population situations. CANUSA-East is cooperating with Chris Sanders (CFS, Sault Ste. Marie) in a small scale effort designed to gather preliminary field data on the relationship between pheromone trap catches and budworm population density. A modest number of traps will be placed in non-outbreak infestations in Minnesota, Wisconsin, Michigan, New York, New Hampshire, and Vermont. Sampling for larval population estimates, degree of defoliation, and egg mass densities will be done near each trapping site. Hopefully, these preliminary data will facilitate better planning for a more comprehensive field test of this tool in 1981.

Shelterwood Management for Budworm-resistant Forests

The fir budworm, the spruce-fir budworm, or perhaps, the spruce worm? A spruce budworm by any name will do the same damage, but a forester knows that balsam fir is the tree species most likely to be damaged in budworm epidemics.

By capitalizing on this fact, research foresters at the Northeastern Forest Experiment Station's Orono, Maine, laboratory hope to make the Northeast's spruce-fir forests more resistant to the budworm and decrease dependence on insecticides as a method of budworm control.

Silviculturist Bob Frank is employing "shelterwood" management methods on 140 acres (57 ha) of spruce-fir in the Penobscot Experimental Forest. Frank says they are only doing "what nature might do."

One technique, the three-stage method, calls for an initial harvest to remove overmature, defective, or slow-growing trees. Less desirable species are also removed. The objective is to let in more light, accelerate the growth rate, and encourage trees to root themselves more firmly against the wind.

In a second harvest, about 10 years later, more large overstory trees are removed and further thinning takes place.

Five years later, the third shelterwood or final harvest is completed. It may include both a precommercial thinning and removal of the remaining overstory trees. Merchantable stock and all trees over 2 in. (5 cm) in diameter are removed.

The remaining seedlings and small saplings are left to grow. By the time they reach the pole stage, as much as 75 percent of the potential crop trees in the new stand will be spruce; the rest will be balsam fir, eastern white pine, paper birch, and eastern hemlock.

From a stand with at least 15 times as many fir as spruce, Frank's method produces a new seedling stand with approximately equal numbers of the two species.

Trees regenerate naturally in a shelterwood area, says Frank. The changes that occur are necessarily slow and he sees no immediate end to the use of insecticides. But, says Frank, the shelterwood approach should eventually produce forests that by their very nature are more resistant to spruce budworm attack.

The Market Place — Another Arena in which To Deal with the Spruce Budworm Problem?

Balsam fir is an underutilized tree species. Papermakers, furniture manufacturers, homebuilders, and even fuelwood suppliers pass it by for other species. But not the spruce budworm.

In 1969, over 100,000 acres (40,689 ha) of spruce-fir forests in the Superior National Forest were defoliated. Balsam fir, in particular, was severely damaged and subsequent mortality in this species has been high.

Resource managers are trying to increase use of the fir resource because large components of fir in the forest promote budworm epidemics, resulting in substantial periodic losses in forest inventory and decadence of a natural forest type. The USDA Forest Service, through the Canada/United States Spruce Budworms Program (CANUSA), is funding research at the University of Minnesota to assess the economic potential for using large volumes of unused balsam fir.

The University of Minnesota research team is led by Drs. Sinclair, Bowyer, Gertjejansen, and Neuman in the Forest Products Department. Principal cooperators are Region 9 of the USDA Forest Service, St. Louis County, and the Minnesota Department of Natural Resources.

Industrial cooperation is with Blandin Paper and Wood Products Corporation as well as other representatives of the Minnesota timber industry. In addition to grants from CANUSA-East, the project is partially financed by McIntyre-Stennis funds and the University of Minnesota Agricultural Experiment Station.

Project objectives are: evaluate the technical basis for prejudice against the use of fir in wood products for which it is suited; determine the time course of decline in technical quality of salvage fir in relation to product potential; and develop processes and products with potential to enhance utilization of balsam fir.

The project has already produced a waferboard made from fir that appears in pilot studies to exceed the product standards of the National Particleboard Association. Conventional processing technology was employed to produce the fir product. Market acceptance will insure a broader supply base for the waferboard industry in the Lake States. In Maine, where substantial fir volumes are expected to become available because of the budworm epidemic, a major new market for fir could become available when it is most needed.

Field plot data the team is collecting should make a major contribution to planning salvage operations in budworm epidemics. Hitherto, these have been guided by silvicultural and road construction considerations. But product potential may be the key to holding down costs.

New Brunswick Appointment

Dr. Gordon Baskerville, a professor of forest ecology at the University of New Brunswick, has been appointed Assistant Deputy Minister of forest resources in the N.B. Ministry of Natural Resources. According to Minister J.W. Bird, Dr. Baskerville has the ability to develop long-term policies to help combat the forest insect problem. "We need a new fundamental approach to plan the forest management and the development of crop protection techniques which will be an alternative to the present use of chemical insecticides," he stated.

Salvage of Budworm-killed Trees

Battle casualties from our forest wars — trees killed by the spruce budworm — may yet serve us honorably. They may become useful lumber or wood composite building materials, according to Forintek Canada Corporation Limited.

Research is underway at the Eastern Forest Products Laboratory of Forintek Canada Corp., in cooperation with the Maritime Lumber Bureau and the Canadian Forestry Service, to seek uses for budworm-killed trees, many of which have been dead for years. When completed, the work, which is funded by the Federal government, should help to protect industry and jobs in the Maritimes. Forintek has the equipment and, far more important, the expertise of its scientists making the corporation uniquely suited to this task.

Funding For 1980 Spruce Budworms Research

The following individuals and institutions or agencies have been approved for funding:

CANUSA-U.S.-West

1. Budworm outbreaks relationship to site character.
   G.E. Long,
   Washington State Univ.,
   Pullman, Washington
2. Factors determining density and quality of western spruce budworm.
   William E. Waters,
   Univ. of California,
   Berkeley, California
3. Pheromone traps to predict defoliation by western spruce budworm.
   Charles Sartwell,
   USDA-FS PNW-FSL,
   Corvallis, Oregon
4. Avian and mammalian predation on western spruce budworm.
   Edward O. Garton,
   Univ. of Idaho,
   Moscow, Idaho
5. Orthene medicaps implanted to protect grand fir and Douglas-fir.
   Richard C. Reardon,
   USDA-FS PSW,
   Davis, California
6. Biocontrol with the entomogenous nematode, *Neoaplectana carpocapsae*.
   Harry K. Kaya,
   Univ. of California,
   Davis, California
7. Bioassay of conventional insecticides for control of western spruce budworm.
   Michael Haverty,
   USDA-FS-PSW,
   Berkeley, California
8. Bioassay of insect growth regulators on the western spruce budworm.
   Michael Haverty,
   USDA-FS-PSW,
   Berkeley, California
9. Prediction of optimal spray time of insect growth regulators during development of western spruce budworm.
   J.L. Robertson,
   USDA-FS-PSW,
   Berkeley, California

CANUSA-U.S.-East

1. Basis of host plant selection by spruce budworm.
   P.J. Albert,
   Concordia Univ.,
   Montreal, Que.

2. Model to predict dispersal of spruce budworm larvae.
   C. Mason,
   Aeromatric Inc.,
   Ann Arbor, Mich.
3. Method to monitor air levels of spruce budworm pheromone.
   E.A. Meighan,
   McGill univ.,
   Montreal, Quebec
4. Pheromone variability within and between spruce budworm populations.
   W.L. Roelofs,
   Cornell Univ.,
   Ithaca, N.Y.
5. Adult parasite densities in low spruce budworm populations.
   G.A. Simmons,
   Michigan State Univ.,
   E. Lansing, Mich.
6. Selection of baculovirus strains resistant to U.V. radiation.
   G.R. Stairs,
   Ohio State Univ.,
   Columbus, Ohio
7. Host plant nitrogen utilization by spruce budworm.
   M.E. Montgomery,
   USDA-FS-NE,
   Hamden, Conn.

CANUSA-Canada-East

1. Formulation screening of pheromones (DSS-CFS joint contract).
   Charles Wiesner,
   Research & Productivity Council,
   Fredericton, N.B.

Reports Available:

The following are available from USDA Forest Service, Northern Region (P.O. Box 7669, Missoula, Montana 59807):

1. "Effects of Dipel® wettable powder for foliage protection against western spruce budworm 1 and 2 years following aerial application," Report No. 80-9 by Wayne Bousfield and Tom Flavell.
2. "The effects of height growth loss on stands damaged by the western spruce budworm," Report 80-11 by Wayne Bousfield.

Also available from USDA Forest Service, Southwestern Region (517 Gold Avenue, S.W., Albuquerque, New Mexico 87102):

1. "Western spruce budworm damage assessment project 1979," Report No. 80-5 by Catherine R. Stein.

CANUSA-West has published "Nomenclature of Nearctic Conifer-Feeding Choristoneura (Lepidoptera: Tortricidae): Historical review and present status," by Jerry A. Powell. Ask for General Technical Report PNW-100 from Pacific Northwest Forest and Range Experiment Station, 809 NE Sixth Avenue, Portland, Oregon 97232.

The Newfoundland Forest Research Centre has issued Report N-X-179 by H. Crummey and I. Otvos, entitled "Biology and habits of the eastern spruce budworm in Newfoundland." Available from Nfld. FRC, P.O. Box 6028, St. John's, Newfoundland A1C 5X8.

The Proceedings from the Symposium on "Aminocarb — effects of its use on environmental quality" at the Université de Moncton 23-24 August 1978 is available from the Coordinator, Dr. Victorin N. Mallet, Université de Moncton, Moncton, N.B. A1A 3E9.

We have also seen the final report by L. Hamel and Yvan Hardy," Caractérisation des foyers d'infestation de la tordeuse des bourgeons de l'épinette. II. Les aspects climatologiques," available from Dr. Hardy, Laval University, Faculty of Forestry and Geodesy, Quebec, P.Q. G1K 7P4.

A large bundle of information reports from the environmental impact crew at the Forest Pest Management Institute landed on the desk of the editor recently: Aquatic impact studies by S. Holmes (FPM-X-26); Impact at various spray timings by P. Kingsbury and B. McLeod (FPM-X-29); Permethrin in streams by Kingsbury and D. Kreutzweiser (FPM-X-27); Terrestrial impact of Permethrin by Kingsbury and McLeod (FPM-X-28); Environmental assessment of semi-operational permethrin application by Kingsbury and Kreutzweiser (FPM-X-30); Azamethiphos in terrestrial and aquatic environments by Kingsbury et al (FPM-X-33); Effect of sequential applications on birds by Kingsbury and McLeod (FPM-X-34); Nonylphenol in aquatic systems by Holmes and Kingsbury; and Permethrin in trout streams by Kingsbury and Kreutzweiser. Busy, weren't they? Copies may be obtained from P.D. Kingsbury at FPMI, P.O. Box 490, Sault Ste. Marie, Ontario P6A 5M7.

Other Reports Available

"Field techniques for assessing the impact of the spruce budworm in Michigan's Upper Peninsula," by Thomas P. Mog and J.A. Witter, is available from the authors at the University of Michigan School of Natural Resources in Ann Arbor, Michigan 48109.

"Deterministic and stoichastic analyses of the optimal timing of multiple applications of pesticides with residual toxicity" and "Applications of dynamic programming to pest management" by Christine A. Shoemaker, Department of Environmental Engineering, Cornell University, Ithaca, New York 14850.

"Comparison of spruce budworm overwintering populations with emerged populations (peak L_2) in the Lower St. Lawrence Region of Quebec, 1978," by J.R. Blais, Laurentian Forest Research Centre, Sainte-Foy, Quebec.

"Western spruce budworm defoliation trend relative to weather in the Northern Region 1969-1979." by J. Hard, S. Tunnock and R. Eder. Issued by the USDA Forest Service, Northern Region, Report No. 80-4.